AMD
Smarter Choice

AMD Graphics Developer Performance Tools

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AMD Graphics - Performance Tools

March 07, 2007

Overview

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- Graphics Performance Tools Overview
- GPU PerfStudio
- GPU ShaderAnalyzer
- Tootle
- Other AMD Graphics Tools
- Summary

Graphics Performance Tools Overview

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AMD Graphics Tools

- Real-time performance analysis
  - GPU PerfStudio – Interactive graphics tuning
- Static resource analysis
  - GPU ShaderAnalyzer - Shader performance analysis
  - Tootle - Triangle mesh optimization

External Graphics Tools

- PIX plugin – support for AMD counters (DirectX)
- gDEBugger - support for AMD counters (OpenGL)

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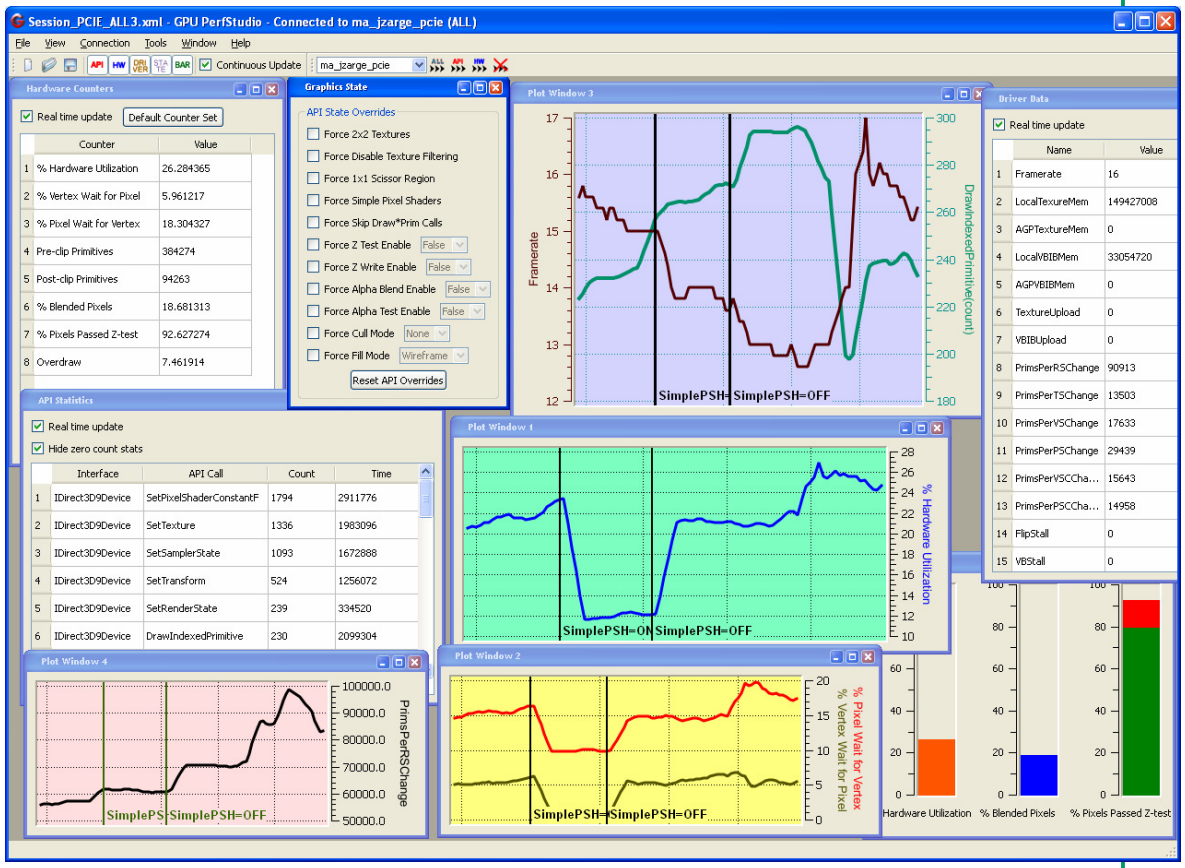
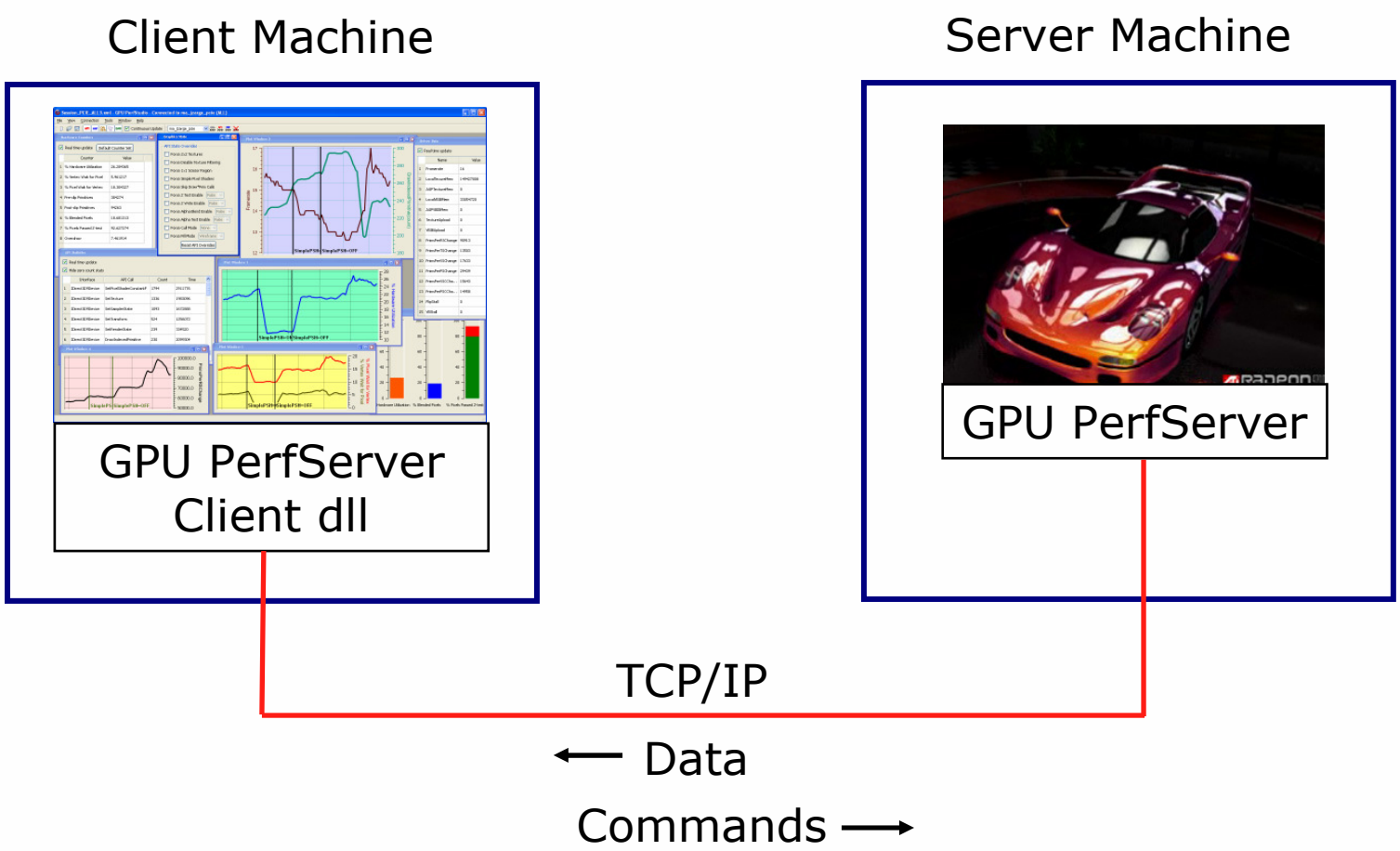
GPU PerfStudio

GPU PerfStudio Overview

- Monitor performance while D3D or OpenGL application executes remotely
- Real-time visualization:
  - API statistics
  - Hardware/driver data
- Override rendering states
- Launch remote applications
- Flexible data plotting



GPU PerfStudio: Client/Server



GPU PerfStudio: New Features

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- DX10/Vista/R600
  - ability to analyze cutting edge applications on the newest hardware
- OpenGL
  - support for OpenGL applications
- Render target and non-RT state overrides
  - Especially useful for image-space effects
    - depth of field, glows, render to texture
- Data filters
  - For gaining additional insight into your data
    - average, median, min, max, derivative
- Plot marker lines
  - Demonstrate the effect of state override on performance data

GPU PerfStudio: New Features (cont.)

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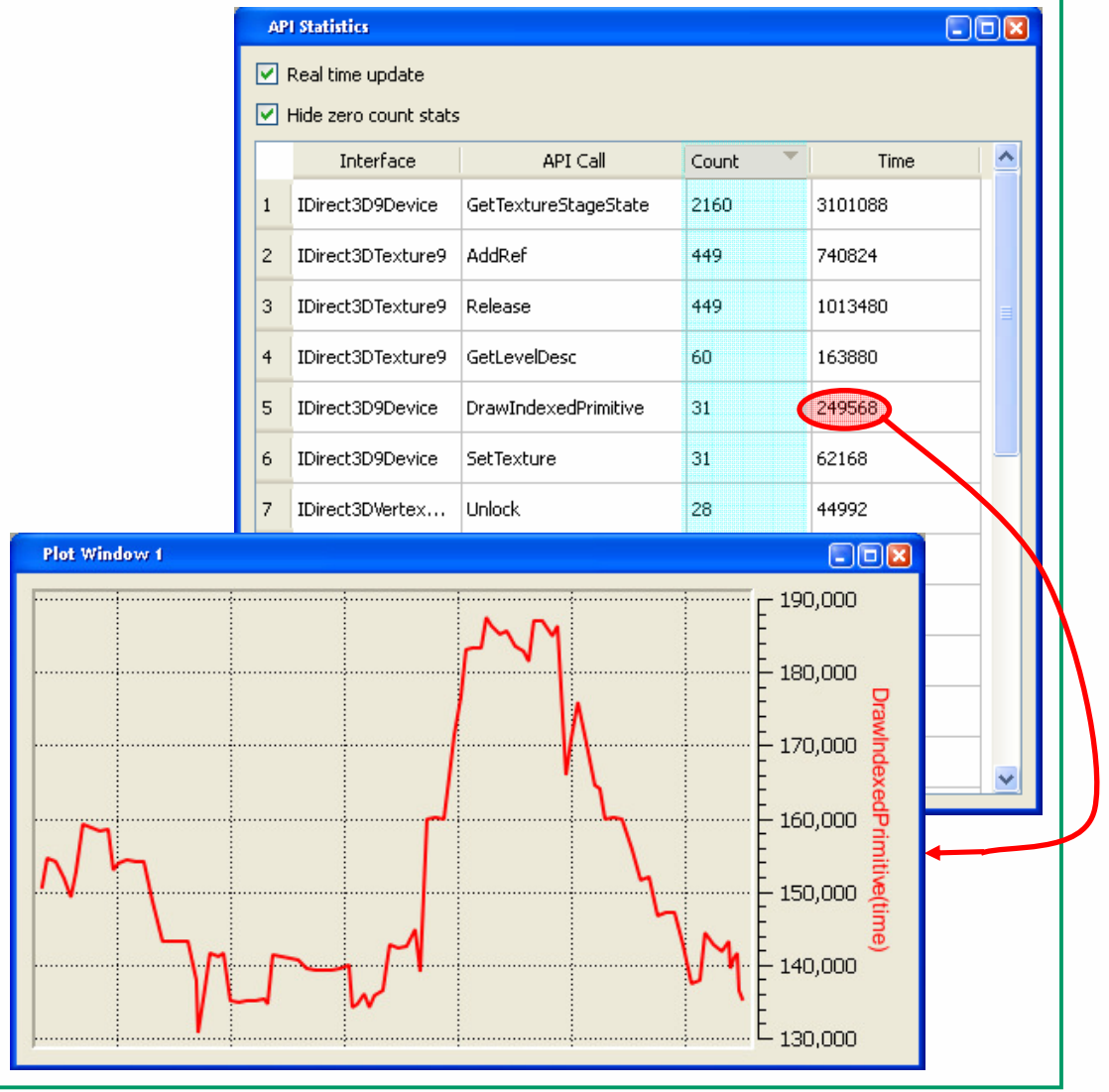
- Flexible bar charts
  - Control colors, sizes, alarm, range
- Table cell formatting
  - Customize the layout of your tables
    - Cell size, color, font
- Convenience features
  - Application remembers recent sessions, recent server machines, recent applications, etc.
- Selectable antialiasing
  - Fine tune the look and performance of GPU PerfStudio

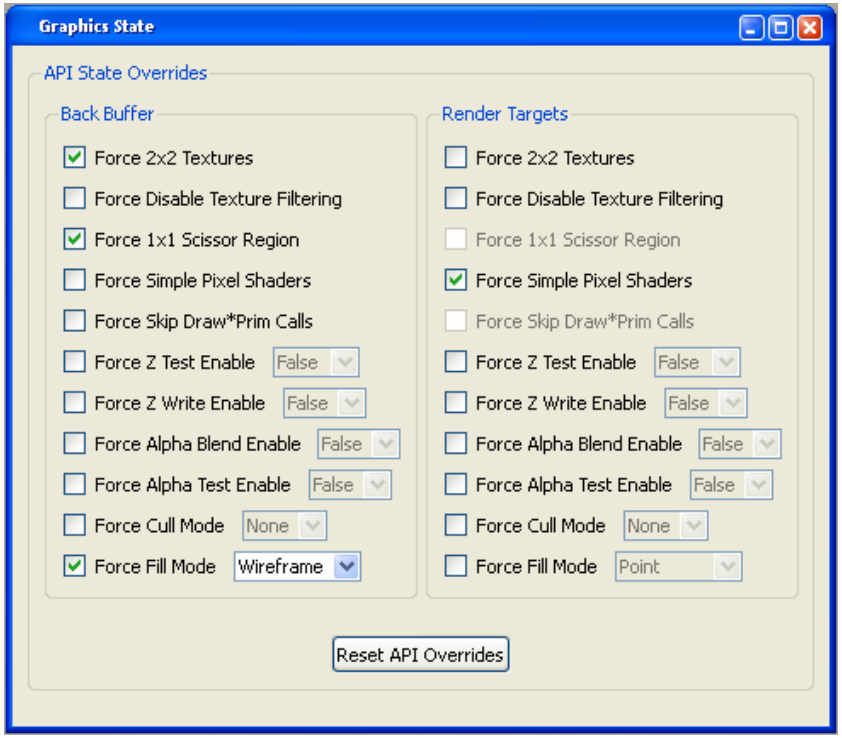
GPU PerfStudio Features: API Statistics

- Per-frame D3D and OpenGL API call data
- Sorting of API call counts and times
- Flexible plotting of all numeric data
- Plot window properties control appearance



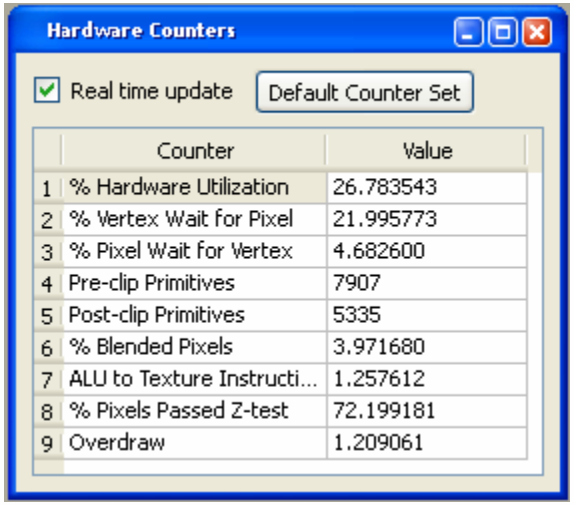
GPU PerfStudio Features: API Statistics

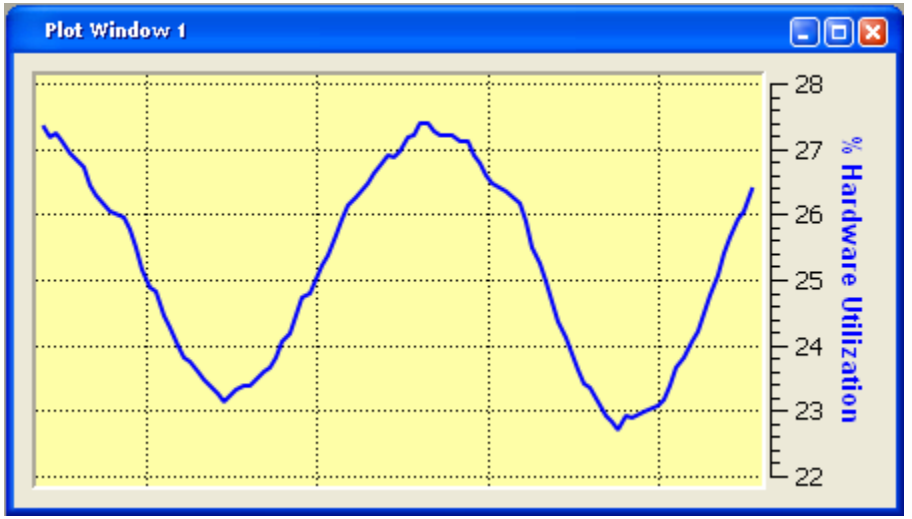
- Real-time state overrides
  - Render Target and non-RT state overrides
  - Useful for full-screen effects



GPU PerfStudio Features: Hardware

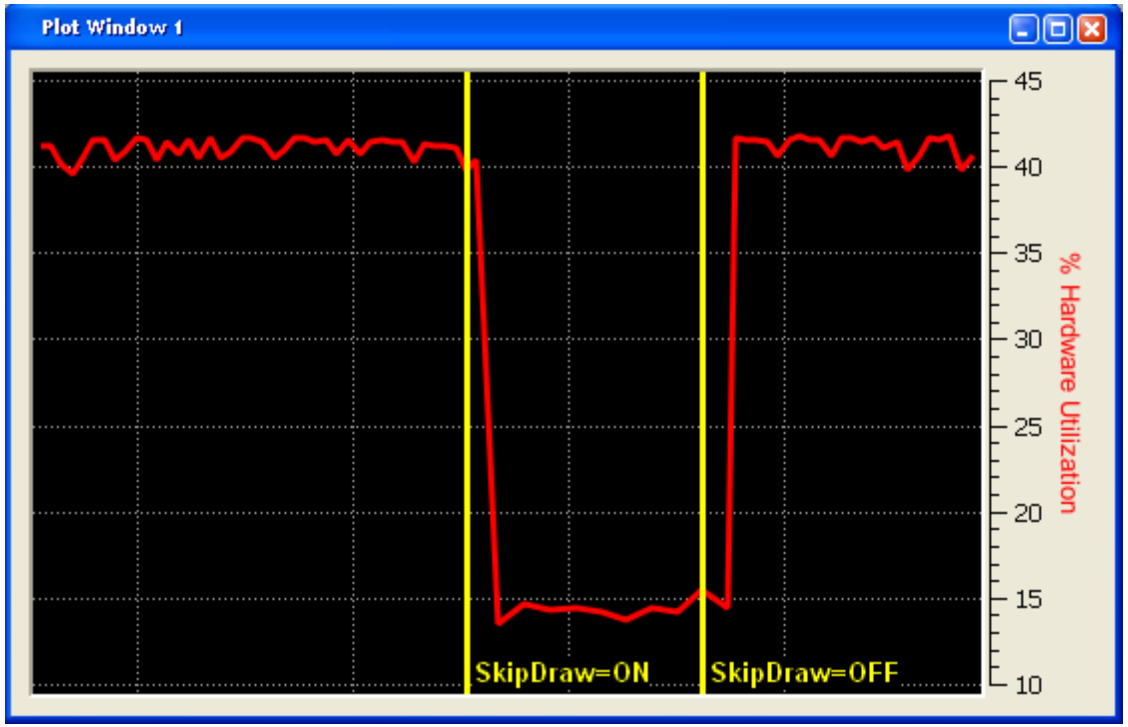
- Hardware counters include:
  - % Hardware Utilization
  - Primitive counts
  - Pixel vs. vertex bounded
  - % Pixels passed Z-test
- Editable table properties
  - Cell size, font, colors
- Plotting of all numeric data
  - Filters include: average, median, min, max, derivative





GPU PerfStudio Features: Plotting

- Marker lines to indicate frame of API state change
- Multiple data series on single plot
- Plot properties:
  - Data axis
  - Axis range
  - Grid axis
  - Tick label format
  - Line width
  - Marker properties
  - Filter properties
  - Antialiasing
  - Plot colors



GPU PerfStudio Features: Bar Charts

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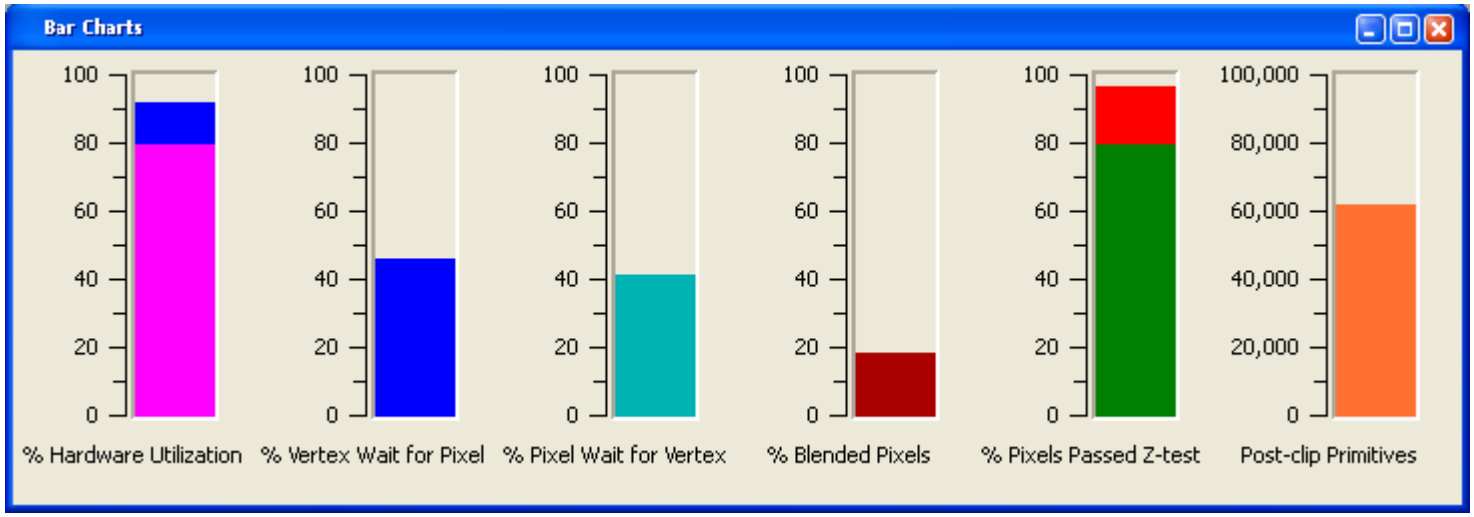
- Flexible bar charting mechanism
- Customizable “alarm” level
- Tick label format
- Minimum and maximum range values
- Data filtering



GPU PerfStudio Preferences

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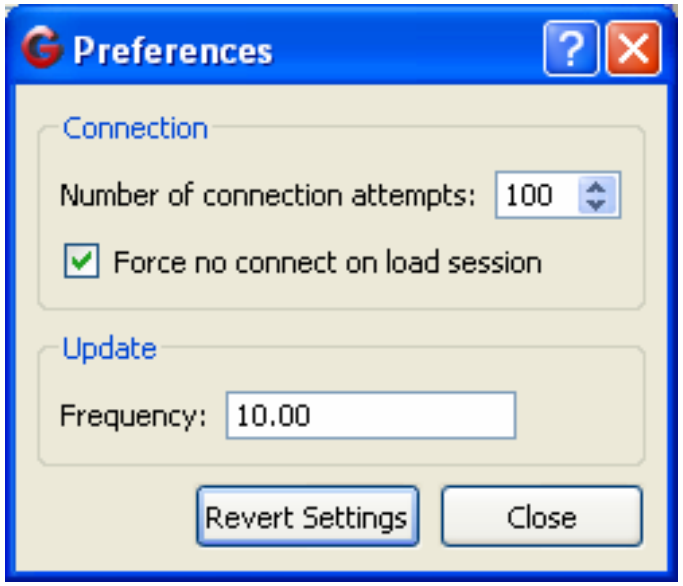
- Preferences are application based, not per session
- Connection preferences:
  - Number of connection attempts
  - Force GPU PerfStudio to not connect when a session is opened
- Modify the update frequency - number of updates per second



Performance Tuning w/GPU PerfStudio

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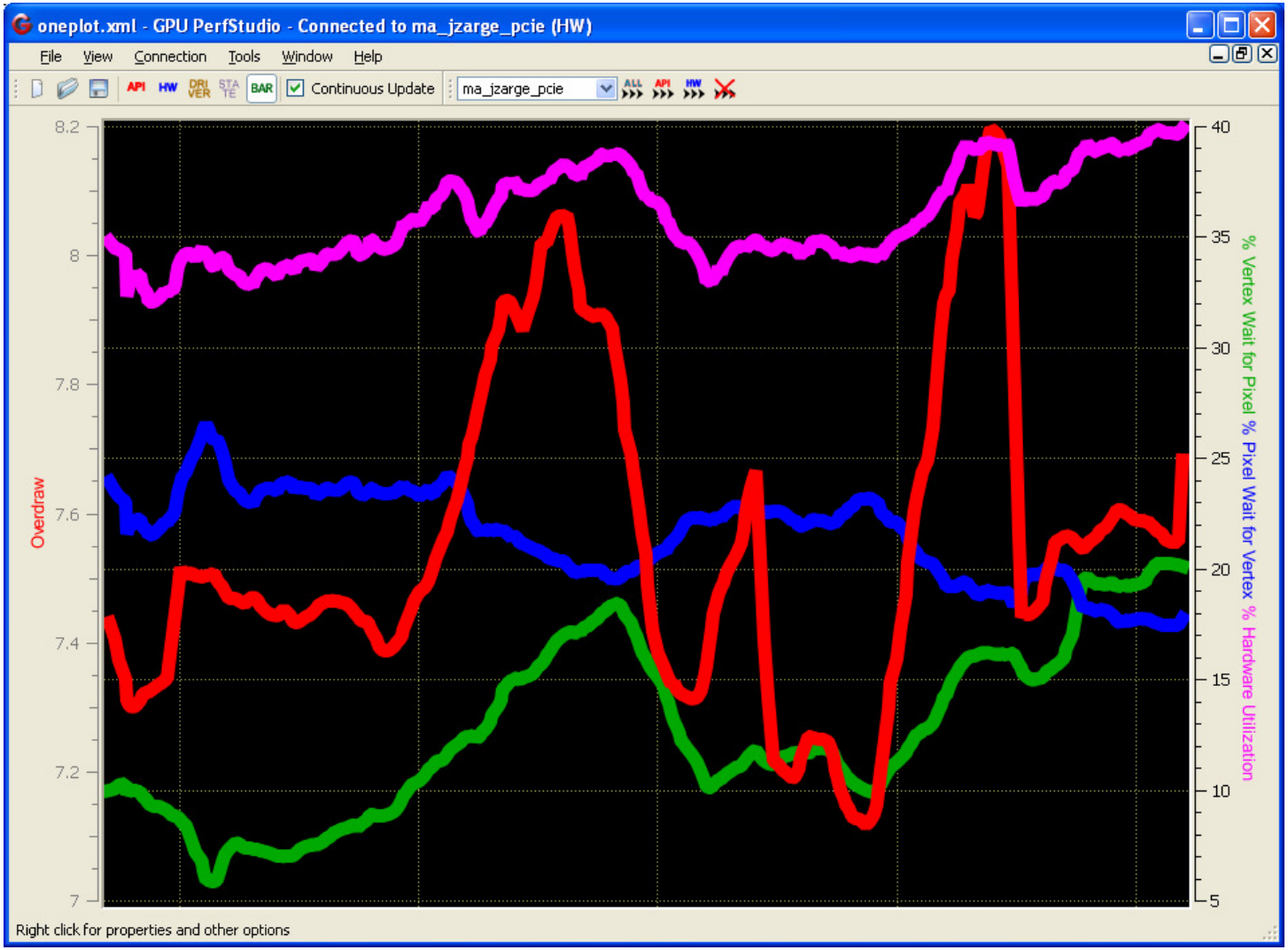
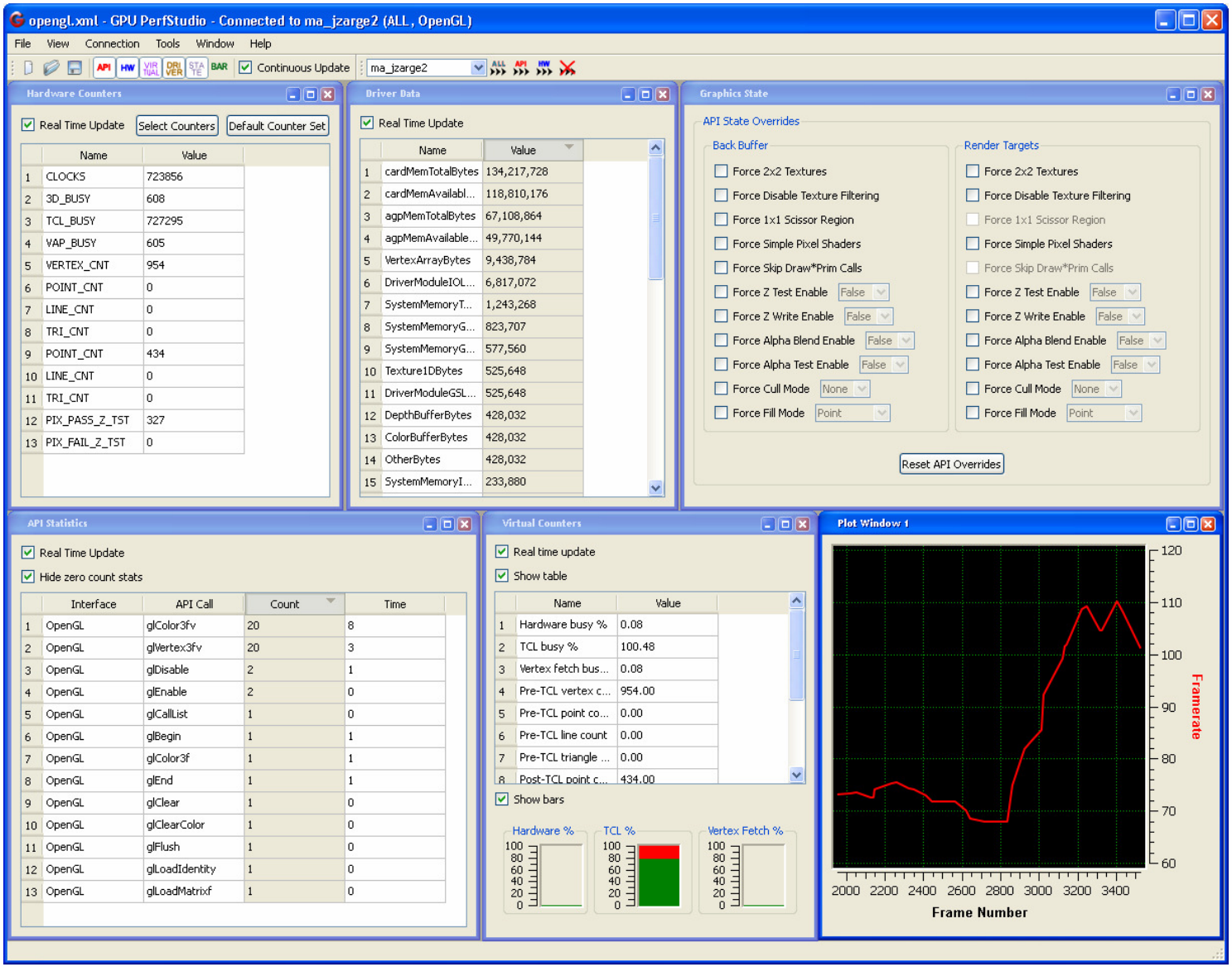
- CPU vs GPU balance
  - Is the GPU saturated?
- Pixel/Vertex waiting
  - Is vertex processing the bottleneck?
- Pixel shader bottleneck
- Draw*Primitive per state change
  - Good indication of batch size
- Inefficient use of API
- High memory usage
- Texture bandwidth and filtering
- Efficient use of z-buffer and sorting
- Wireframe for geometry visualization

GPU PerfStudio Demo



GPU PerfStudio - OpenGL



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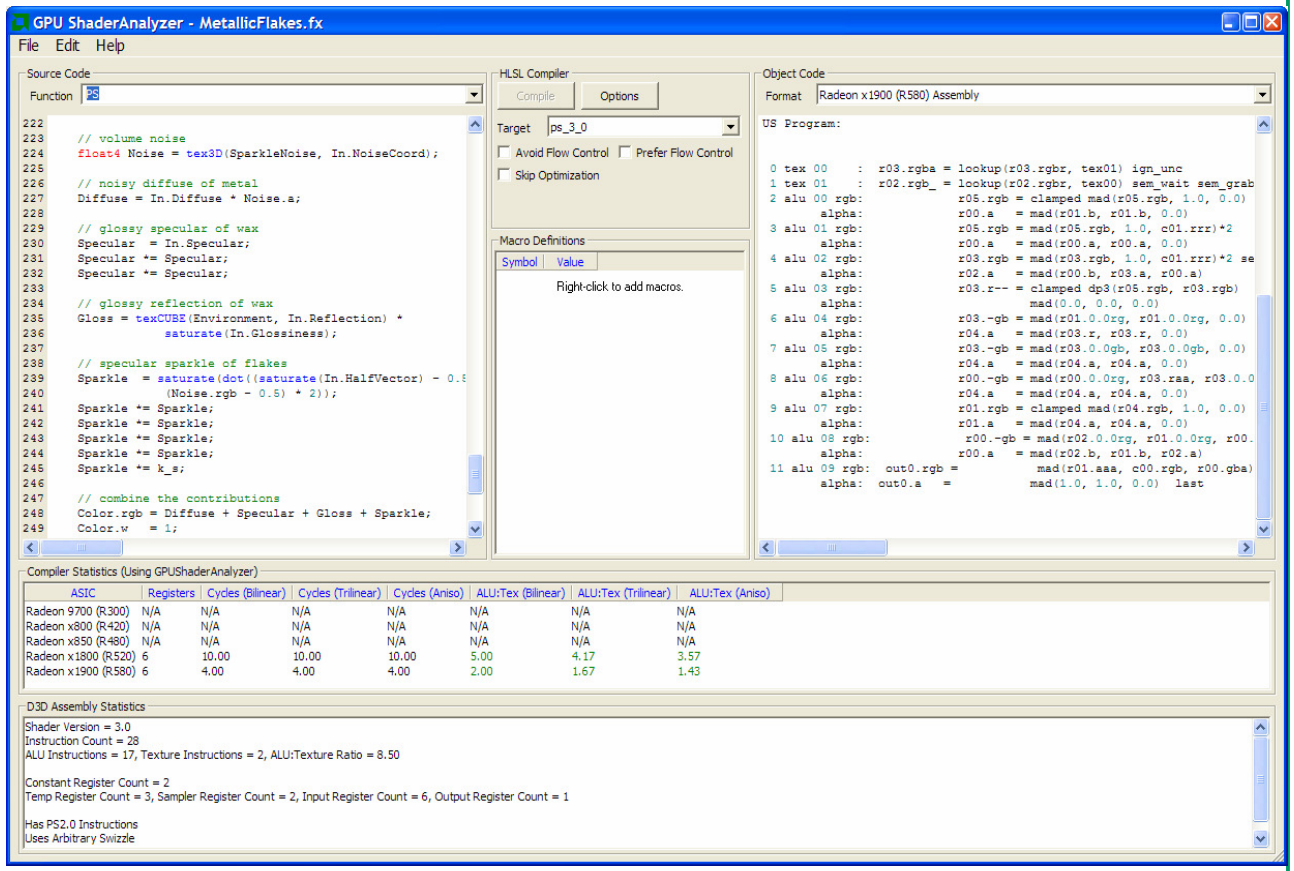
GPU ShaderAnalyzer

GPU ShaderAnalyzer

- Shader performance analysis tool
- Shader tuning environment
- Instant performance feedback as you tune your shaders



GSA Features: Performance Analysis

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Compiler Statistics (Using Catalyst 7.1)

ASIC	Registers	Cycles (Bilinear)	Cycles (Trilinear)	Cycles (Aniso)	ALU:Tex (Bilinear)	ALU:Tex (Trilinear)	ALU:Tex (Aniso)
Radeon 9700 (R300)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Radeon x800 (R420)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Radeon x850 (R480)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Radeon x1800 (R520)	4	8.00	8.00	8.00	2.00	1.67	1.43
Radeon x1900 (R580)	4	4.00	4.80	5.60	1.00	0.83	0.71

- Predicts shader performance on range of AMD GPUs.
- Analyzes the compiled hardware instruction stream.
- Displays estimated cycle count & ALU:Texture instruction ratio.
- Color codes ALU:Tex ratio based in whether shader is ALU or texture bound.
- Analysis is tied to specific Catalyst driver releases.

GSA Features: Performance Analysis

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- Analysis method considers static & dynamic flow control.
  - Calculates the cost of each side of a branch to calculate the minimum, maximum & average number of cycles to execute.
  - Factors in the expected flow control coherence.
  - Currently only average cycles is displayed but minimum & maximum available from command line analysis.
- Estimates cost of texture instructions with bilinear, trilinear & anisotropic filtering.
  - Cost based on typical texture fetch cost, not theoretical maximum.

GSA Features: Hardware Disassembly

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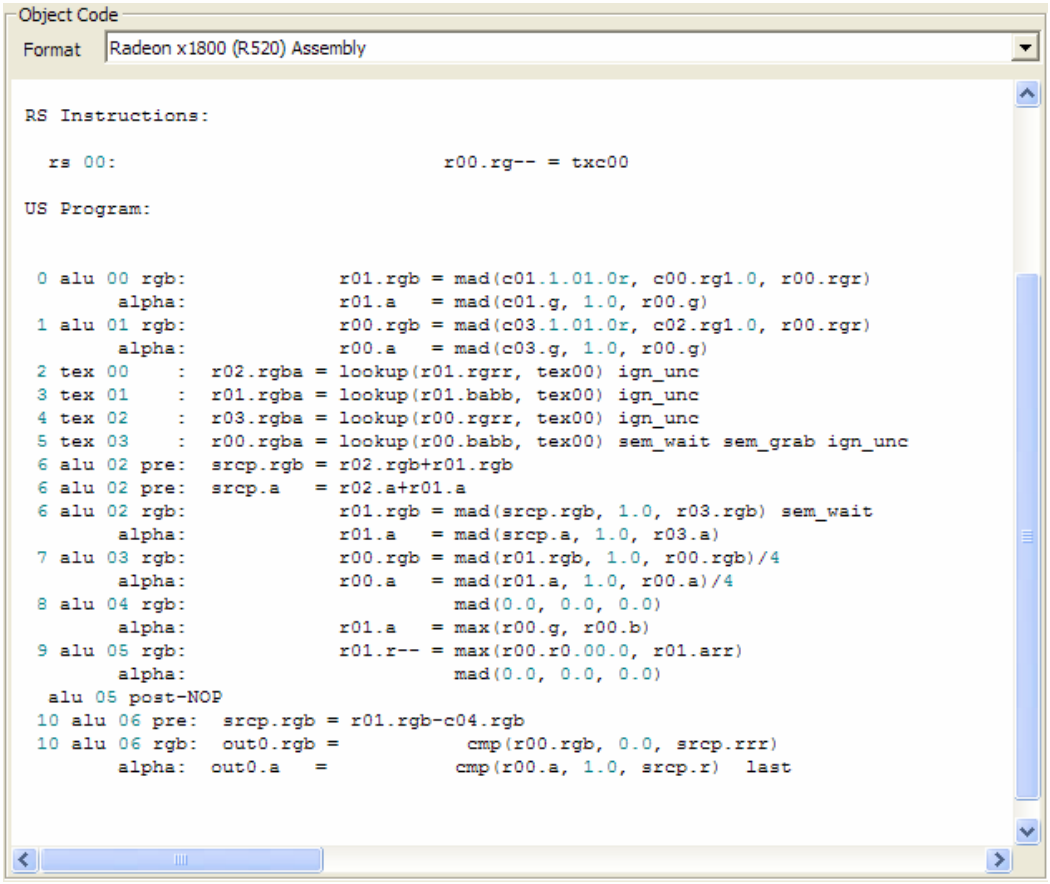
- View the actual shader as executed by the hardware.
- Shows the effects of optimizations made by the hardware shader compiler.
- No wondering where your shader performance is going.
- Can also display D3D shader disassembly.



GSA – Supported Shader Formats

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- DX9 Pixel\Vertex Shaders
- DX 1.1 – DX3.0 Assembly Shaders
- DX 2.0 – DX3.0 HLSL Shaders
- DX10 Pixel\Vertex\Geometry Shaders
- GLSL Pixel\Vertex Shaders
- arb_fp\arb_vp programs

GSA Features: Shader Editing

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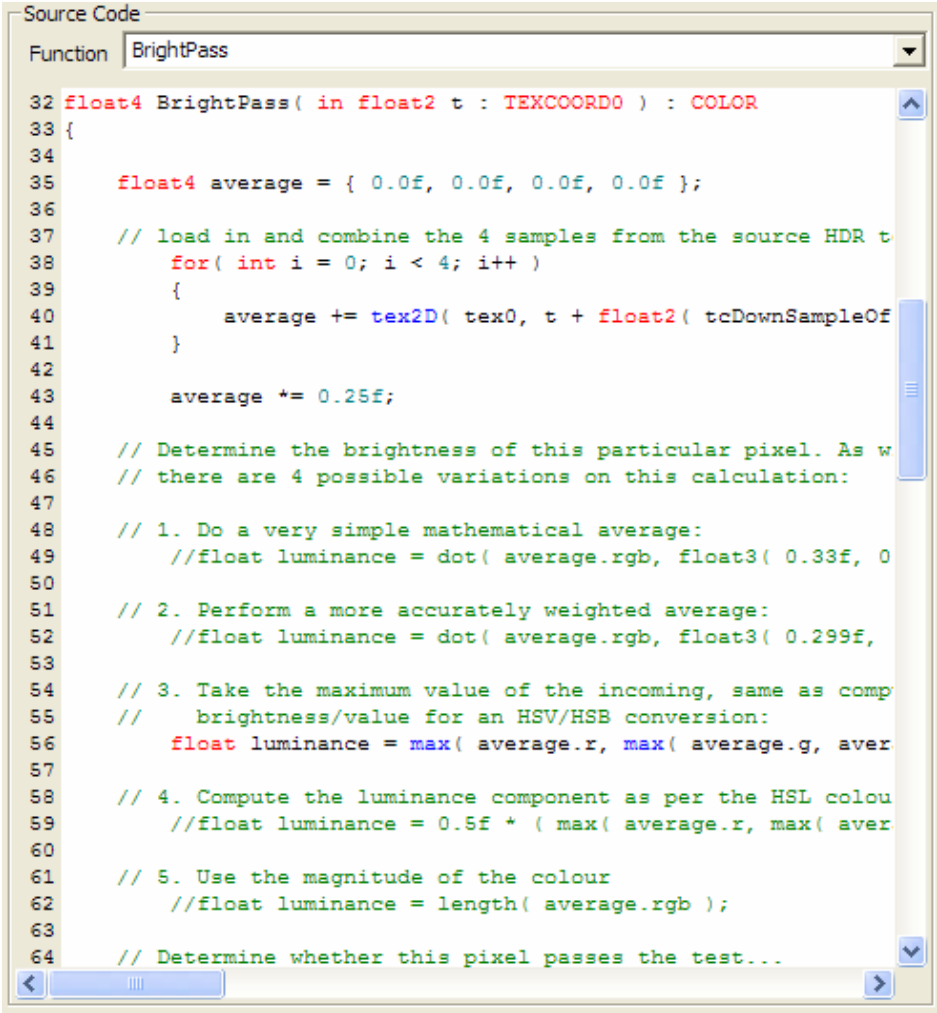
- Fully featured editor.
- All the aids you have come to rely one.
  - Cut\Copy\Paste.
  - Undo\Redo.
  - Etc.
- Context coloring.



GSA Features: Options

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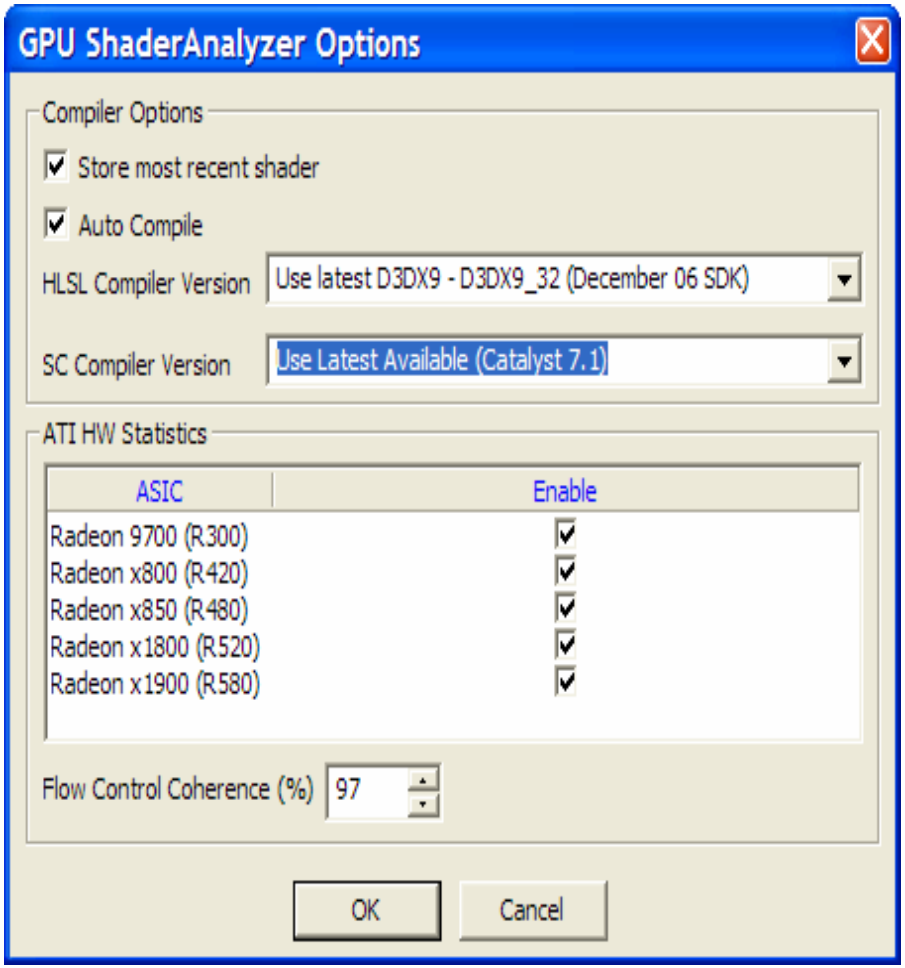
- Configure which HLSL compiler to use.
  - Currently supports Microsoft D3DX compilers from Feb 05-current.
- Configure which version of the ATI Shader Compiler to use.
  - Track performance against driver releases.
- Configure which GPUs to analyze performance for.



GSA Features: Command Line Support

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- Shader performance analysis & hardware disassembly also available from command line.

- Analyze a single shader or a search a directory tree for shaders.

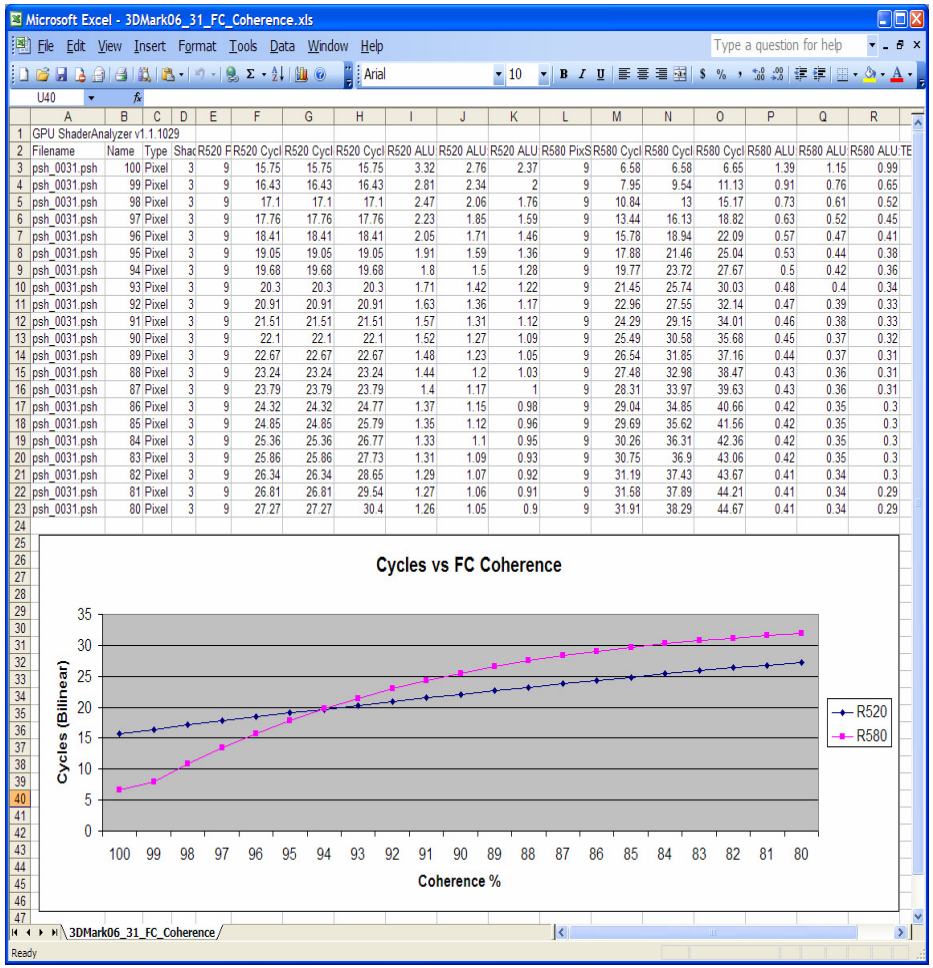
- Output analysis to .csv file for further analysis within MS Excel.

GSA Features: CSV Analysis Output

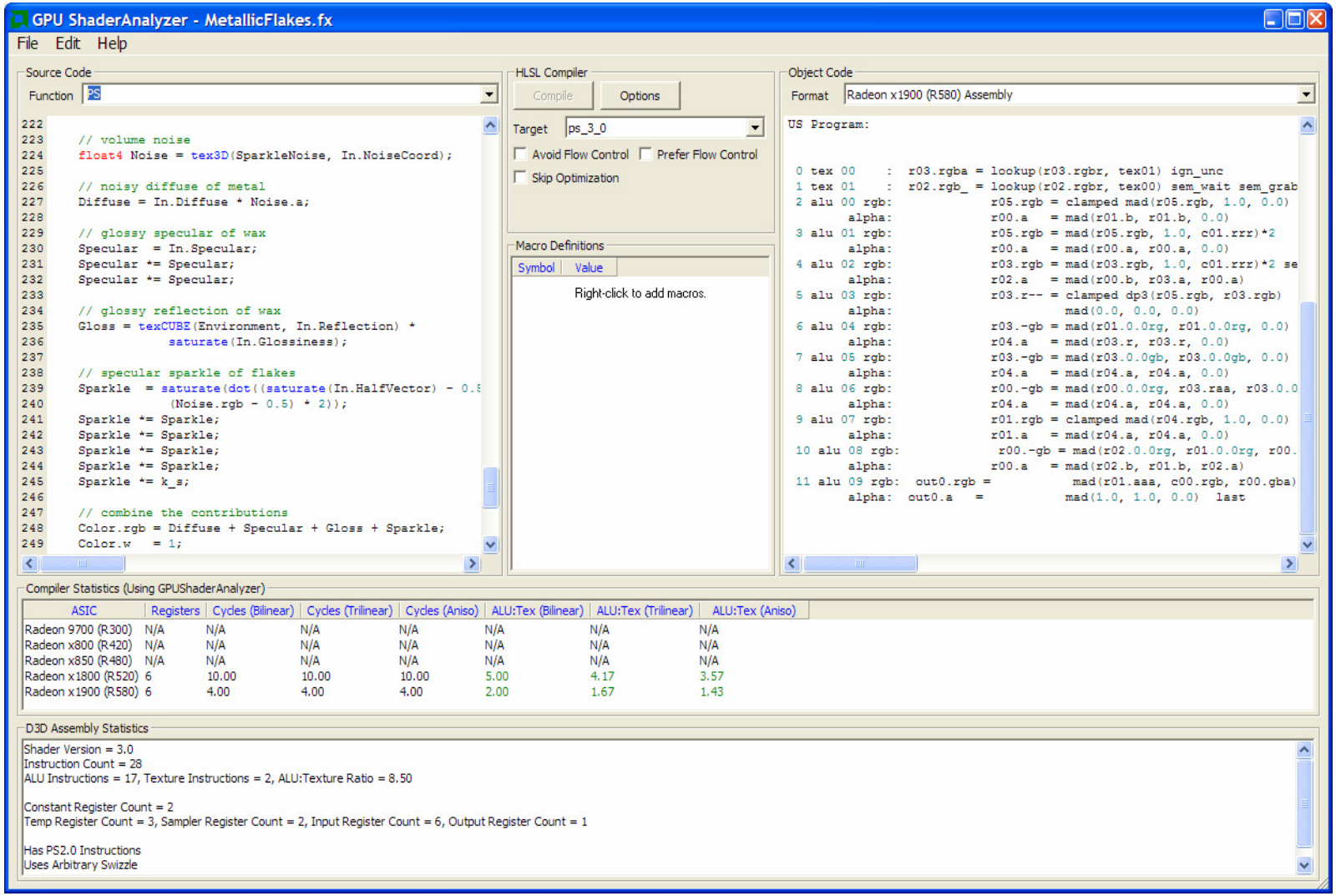
CSV output & MS Excel gives endless options for deeper investigation.

Example:

- Pixel shader with flow control run through GSA with different FC coherence values set.
- Graph performance against coherence.



GSA: Demo


GPU ShaderAnalyzer - MetallicFlakes.fx
File Edit Help
Source Code
Function PS
222
223 // volume noise
224 float4 Noise = tex3D(SparkleNoise, In.NoiseCoord);
225
226 // noisy diffuse of metal
227 Diffuse = In.Diffuse * Noise.a;
228
229 // glossy specular of wax
230 Specular = In.Specular;
231 Specular *= Specular;
232 Specular *= Specular;
233
234 // glossy reflection of wax
235 Gloss = texCUBE(Environment, In.Reflection) *
236 saturate(In.Glossiness);
237
238 // specular sparkle of flakes
239 Sparkle = saturate(dot((saturate(In.HalfVector) - 0.5
240 (Noise.rgb - 0.5) * 2));
241 Sparkle *= Sparkle;
242 Sparkle *= Sparkle;
243 Sparkle *= Sparkle;
244 Sparkle *= Sparkle;
245 Sparkle *= k_s;
246
247 // combine the contributions
248 Color.rgb = Diffuse + Specular + Gloss + Sparkle;
249 Color.w = 1;
HLSL Compiler
Compile
Options
Target ps_3_0
Avoid Flow Control
Prefer Flow Control
Skip Optimization
Macro Definitions
Symbol
Value
Right-click to add macros.
Object Code
Format Radeon x1900 (R580) Assembly
US Program:
0 tex 00 : r03.rgba = lookup(r03.rgbr, tex01) ign_unc
1 tex 01 : r02.rgb_ = lookup(r02.rgbr, tex00) sem_wait sem_grab
2 alu 00 rgb: r05.rgb = clamped mad(r05.rgb, 1.0, 0.0)
alpha: r00.a = mad(r01.b, r01.b, 0.0)
3 alu 01 rgb: r05.rgb = mad(r05.rgb, 1.0, c01.rrr)*2
alpha: r00.a = mad(r00.a, r00.a, 0.0)
4 alu 02 rgb: r03.rgb = mad(r03.rgb, 1.0, c01.rrr)*2 se
alpha: r02.a = mad(r00.b, r03.a, r00.a)
5 alu 03 rgb: r03.r-- = clamped dp3(r05.rgb, r03.rgb)
alpha: mad(0.0, 0.0, 0.0)
6 alu 04 rgb: r03.-gb = mad(r01.0.0rg, r01.0.0rg, 0.0)
alpha: r04.a = mad(r03.r, r03.r, 0.0)
7 alu 05 rgb: r03.-gb = mad(r03.0.0gb, r03.0.0gb, 0.0)
alpha: r04.a = mad(r04.a, r04.a, 0.0)
8 alu 06 rgb: r00.-gb = mad(r00.0.0rg, r03.raa, r03.0.0
alpha: r04.a = mad(r04.a, r04.a, 0.0)
9 alu 07 rgb: r01.rgb = clamped mad(r04.rgb, 1.0, 0.0)
alpha: r01.a = mad(r04.a, r04.a, 0.0)
10 alu 08 rgb: r00.-gb = mad(r02.0.0rg, r01.0.0rg, r00.
alpha: r00.a = mad(r02.b, r01.b, r02.a)
11 alu 09 rgb: out0.rgb = mad(r01.aaa, c00.rgb, r00.gba)
alpha: out0.a = mad(1.0, 1.0, 0.0) last
Compiler Statistics (Using GPUShaderAnalyzer)
ASIC | Registers | Cycles (Bilinear) | Cycles (Trilinear) | Cycles (Aniso) | ALU:Tex (Bilinear) | ALU:Tex (Trilinear) | ALU:Tex (Aniso)
Radeon 9700 (R300) | N/A | N/A | N/A | N/A | N/A | N/A | N/A
Radeon x800 (R420) | N/A | N/A | N/A | N/A | N/A | N/A | N/A
Radeon x850 (R480) | N/A | N/A | N/A | N/A | N/A | N/A | N/A
Radeon x1800 (R520) | 6 | 10.00 | 10.00 | 10.00 | 5.00 | 4.17 | 3.57
Radeon x1900 (R580) | 6 | 4.00 | 4.00 | 4.00 | 2.00 | 1.67 | 1.43
D3D Assembly Statistics
Shader Version = 3.0
Instruction Count = 28
ALU Instructions = 17, Texture Instructions = 2, ALU:Texture Ratio = 8.50
Constant Register Count = 2
Temp Register Count = 3, Sampler Register Count = 2, Input Register Count = 6, Output Register Count = 1
Has PS2.0 Instructions
Uses Arbitrary Swizzle

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Tootle

Tootle: Overview

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- A Triangle Order Optimization Tool.
- Provided as a library for integration into your tool-chain.
- Simple to use.

Tootle: What It Does

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- Improves vertex-cache hit rate
  - Shade fewer vertices
- Reduces overdraw
  - Shade fewer pixels
  - View independent
- Win-win scenario

Tootle: Background

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- Based on I3D 2006 paper by Nehab\Barczak\Sander.
- Uses D3DXOptimizeMesh to perform vertex cache optimization.
- Uses D3D for overdraw measurement.

Tootle: Overdraw Reduction

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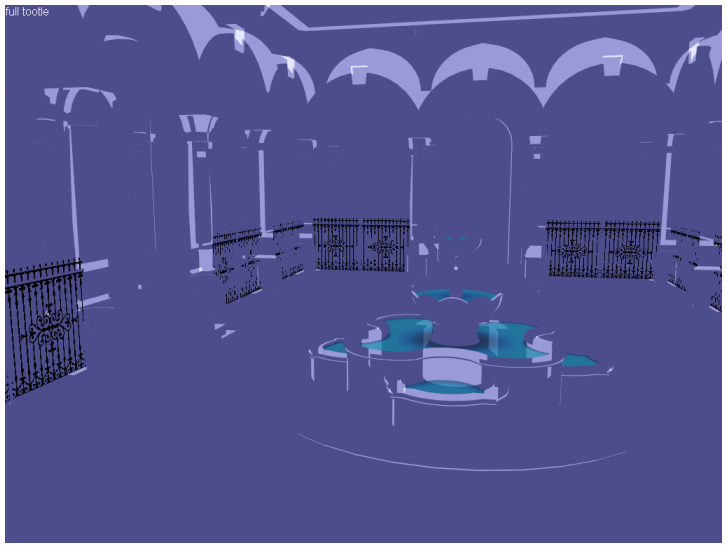
- Example Scene
  - 70k polygons
  - 10 materials
- Reduced overdraw by factor of two.
- 3-7% performance increase compared to D3DXOptimizeMesh.



Tootle: Why you should use it

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- It’s free !
  - No runtime cost.
- It’s free !!
  - Optimizes both vertex & pixel pipelines.
- It’s free !!!
  - Works on all hardware.
- It’s free !!!!
  - To use.

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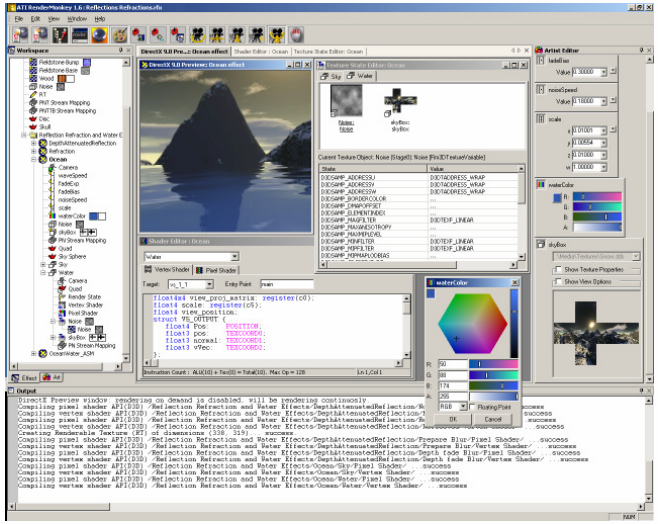
AMD Content Creation Tools

AMD Content Creation Tools



- RenderMonkey
  - Shader development environment
  - Supports HLSL, D3D assembler and GLSL
  - New version coming soon
    - OpenGL ES 2.0 support
    - GPU ShaderAnalyzer integration
- The Compressonator
  - Tool for compressing textures
  - Creates mip-map levels
- CubeMapGen
  - Tool for creating filtered cube maps without seams
  - Uses angular extent filtering
- NormalMapper
  - Automatic normal map generation tool

Other AMD Sessions

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- 10:30-11:30 Massive Multi-Core CPUs and Gaming
  - Justin Boggs
- 12:00-13:00 Performance Profiling With AMD GPU Tools: A Case Study Abstract
  - Holger Gruen
- 12:00-13:00 OpenGL ES 2.0: Start Developing Now (Room 3009)
  - Dan Ginsburg
- 13:30-14:30 Cool GLSL Tips (Khronos Theater)
  - Bill Licea-Kane
- 14:30-15:30 Frostbite Rendering Architecture and Real-Time Procedural Shading and Texturing Techniques
  - Natalya Tatarchuk (with Johan Andersson from DICE)
- 16:00-17:00 Procedural Tools and Techniques for Current and Future Game Platforms
  - Sebastien Deguy (Allegorithmic) & Jeremy Shopf (AMD)
- 9:00-10:00 Massive Multi-Core CPUs and Gaming (Tomorrow, Room 2010)
  - Justin Boggs

Wrap Up

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- AMD GPU Performance Tools are there to make you job easier.
- DX9 versions available now.
- DX10 & OpenGL support coming soon.
- Grab them from ati.amd.com/developer/
- Send us feedback – we want to hear the good & the bad.

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Questions?

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Seth.Sowerby@amd.com
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http://ati.amd.com/developer/

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